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A New Method for Monitoring Cure and Mobility in
Epoxy Matrix and Fiber/Epoxy Interphases

Final Report

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19. ABSTRACT (Continue on reverse if necessary and identify by block number) The objective of this contract was to develop a new method based on reactive labeling technique for monitoring cure and mobility in epoxy matrix and fiber/epoxy interphases. These reactive labels were chosen to exhibit spectral changes in the region of UV-visible and fluorescence spectra where the polymerizing matrix has little absorption or emission. In this method, we take advantage of the magnified effects of the substituent changes in the para and para- positions of conjugated aromatic reactive labels on the UV-visible and fluorescence spectra. We have applied this method to characterize the kinetics and mechanisms of the cure in epoxy networks and in polyurethanes, the imidization process in polyimides, and the acylation in polyamides. One particular advantage of this method is that we can often distinguish between several cure species in some polymers. This advantage makes it possible to follow cure composition throughout the cure process and to analyze the kinetics and the mechanisms of several consecutive polymerization steps in some polymers.				
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A U.S. patent (No. 4,714,674) has been granted in Jan., 1988 for monitoring cure in epoxy networks. Another U.S. patent to cover applications in polyimides and polyurethanes is pending. The following is a list of publications and student theses completed during the period of the contract.

(A) Student Thesis

1. E. Pyun, Ph.D. Thesis, Aug. 1988, "Characterization of Epoxy and Polyimide Cure by UV-Visible and Fluorescence Spectroscopy; Azochromophoric Labeling Approach"
2. W.C. Yu, Ph.D. Thesis, May, 1988, "Azochromophoric Photochemical and Photophysical Tools for the Study of Physical Aging and Epoxy Cure"
3. R. Mathisen, M.S. Thesis, May, 1987, "Development and Application of the Reactive Labeling Technique for Monitoring the Cure of Polyimides"
4. X.Y. Huang, M.S. thesis, Jan. 1989, "Monitoring the Cure of Polyurethane by UV Absorption and Fluorescence Spectroscopy"

(B) Publications

1. C.S.P. Sung, I.J. Chin and W.C. Yu, "A Novel Fluorescence Technique for Monitoring Cure Reactions in Epoxy Networks", *Macromolecules*, 18, 1510, 1985.
2. C.S.P. Sung, "UV-Visible and Fluorescence Characterization of Epoxy Network Polymers Using Chromophore Labelling", *Proceedings of 2nd Japan-US Polymer Symposium*, 283, 1985.
3. C.S.P. Sung and E. Pyun, "Studies on Cure Kinetics and Mobility in Epoxy Network by Azochromophore Labelling Technique", *ACS Polymer Preprints*, 27-1, 78, 1986.
4. C.S.P. Sung, E. Pyun and H.-L. Sun, *Macromolecules*, 19, 2922, 1986.
5. C.S.P. Sung, R. Mathisen and C. Filardi, "Cure Characterization of an Epoxy Network by Trans Diamino-Stilbene Labelling", *ACS Polymers Preprints*, 27-2, 308, 1986.
6. C.S.P. Sung and R. Mathisen, "Characterization of Cure in an Epoxy Network by Fluorescence of trans Diamino-Stilbene Labelling", *Polymer*, 28, 941, 1987.
7. R.J. Mathisen, J.K. Yoo and C.S.P. Sung, "A Dye Labelling Technique for Monitoring Cure of Polyimides and Polyureas; Model Compound Studies", *Macromolecules*, 20, 1414, 1987.
8. C.S.P. Sung, "Application of Reactive Dye Labelling Technique for Cure Characterization of Epoxy Networks," *ACS Symposium Series on Photophysics of Polymer*, Ed. by C.E. Hoyle and J.M. Torkelson, ACS, Washington, 463, 1987.
9. R. Mathisen and C.S.P. Sung, "Imidization Studies of Polyamic Acids by Dye Labelling Technique, *ACS Polymer Preprints*, 28-1, 82, 1987.
10. W.C. Yu and C.S.P. Sung, "Mobility and the Distribution of Free Volume in Epoxy Network by Photochromic Labelling and Probe Studies", *Macromolecules*, 21, 365, 1988.
11. W.C. Yu, C.S.P. Sung and R.E. Robertson, "Site-Specific Labelling and the Distribution of Free Volume in Glassy Polystyrene", *Macromolecules*, 21, 355, 1988.
12. E. Pyun, R. Mathisen and C.S.P. Sung, "Kinetics and Mechanisms of Imidization of a Polyamic Acid Studied by UV-Vis Spectroscopy", *Macromolecules*, 22, 1174, 1989.

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